

REVIEW OF LITERATURE

The literature pertaining to the study on the “**Effect of Interventions on Nutritional Status and Work Performance of Thang - Ta Athletes in Manipur**” is presented in the following headings:

A. National and Global Status of Thang –Ta

B. Nutritional Status of Athletes

C. Nutritional Requirements of Athletes

D. Role of Sport Drinks in Athletic Performance

E. Health Benefits of *Hibiscus sabdariffa* Linn

F. Importance of Nutrition Education for Athletes

A. NATIONAL AND GLOBAL STATUS OF THANG -TA ATHLETES

Thang-Ta is an indigenous Martial art and the cultural heritage of Manipur(Green, 2010).It is the popular term for the ancient Manipuri Martial Art known as HUYEN LALLONG. Its traditional name is Huyel Langlon (Huyel- war; Langlon- knowlwe of Art). Thang – sword and Ta – spear are the main weapons of this art. The movements of the sword and spear intend to ward off evil spirits, while the dance movements indicate protection (**Nongmaithem and Jirgensons, 1998**). It is now recognized by the Ministry of Culture, Government of India as a classical dance form of India (www.Thang-Ta.com). However, the art is developed from the war environment of the tiny state of Manipur in North-east India, which was an independent kingdom since the early Christian era. It played an important role in the geopolitical environment of medieval times in between India and China and many other independent states at war. Constant life and death struggles between clans, tribes of the states resulted in the devising of ways and means of safeguarding the

lives of the citizen soldiery and developing an inward attitude to problems of life, death and afterlife.

The art of the battle envisioned a deep value system view ensconced within the culture of the small ethnic communities struggling for survival from constant attack from hostile neighbours and also to sustain a social order based on rank, status and affiliations of a collective kind. Individual was always in deep relationship with the community using ritual as a means of constant regenerative action with the movement of the spiritual world of ancestors beyond human life. The world of man was an outward revelation of the inner life of the natural world and the universe. This martial art movement develops deep harmony between outer action and inner forces resulted in the use of the body in various forms of expression. (www.thangta.com)

The art of the battle and the use of weaponry, when its warlike engagements were over, developed into a system of wielding objective elements in organic relationship with the cosmos. The body itself became a space where the tensions and dynamics of creation were worked out in a system of movements reflecting the essence of these creative forces. The whole world of the dynamic cosmos was recreated within the world of the body of man.

THANG TA (The art of sword and the spear) thus became an expressive art form which however retained its fighting character at the secret home schools of individual teachers or Gurus, after being prohibited during the period of the colonial raj (1891-1947). It survived during the period of Manipur's integration with the Indian Union in 1949, where the art was shown in festivals and performance platforms abroad since 1976. Unfortunately, the internal system of meditative practices and its essential spiritual character is at risk of being lost through lack of knowledge and committed practice by the present generation. Contemporary theatre practitioners are gaining awareness of its basic energy use and creative exercise of the body's resources which would enhance the performance energy of the artist. It is at an exploratory stage that this new culture is being re-examined.

The movement behaviour of the different parts of the Manipuri martial body is derived from the cultural and habitual uses of daily life. Certain extra-daily postures, positions and movements are compiled into codes adding to the natural repertoire.

Physical Characteristics in Customary Usage and Ritual Practice

(<http://thangtadc.blogspot.in/2009/04/>)

1. **Khurumba** (the bow) in Manipuri dialect refers the forward/downward flexion of the relaxed spine is used.
2. **Tha Leiba** meaning Rotation in Manipuri, tilt of the pelvic joint in different angles while supporting the torso in regular curvilinear uses are most common. Half turn of the chest is also common in rotation movement of the body.
3. **Thong khong** (bridge support) – This squat type is use of the lowering of the upper extremities nearer to the ground, where the two legs in deep bent position that support the whole body, thereby proximally utilizing the use of the upper extremities at the ground level. Three positions of squat in a descending order were mainly used by men to hold the body in pro-gravitational positions.
4. **Wai teiba** - a daily ritual of cleaning the floor by women in Manipur where women use a different flexible squat system with the bent knees opened out to enable the forward flexion of spine. The entire system of body is use and varied. The wrists could be most appropriately used in Khujeng Leibi (Wrist circling) to emulate the figure of eight.

Thang (Art of the sword) in Manipuri emphasizes lowering of one's body near to the ground to enable a spring action for expansion and attack.

TA (Spear) emphasizes an opening out of the body with two forms, 'NONGPHAN' to stimulate the expanse of the sky, and the 'LEIPHAL' emulating the expanse of the earth at the ground level in order to reach out to all directions of space. The spear uses mostly about 75% of the lower extremities in motion, while the wielding of the sword normally takes 75% exercise of the upper extremities of the body.

The martial system is a much more vigorous use of the body in order to reach out to the space of the opponent, and the two arts are derived from the physiographic and cultural environment of the Manipur plains and the hills. The Meitei community in the plains was the pre-dominant ethnic groups mostly capable of using both sword and spear in its weapon system. The Meitei people in the mediable time often use more movement than stillness while preparing to fight the opponent and the self as

target, moving and shifting position often. There is also the use of stillness while awaiting the attacking move of the opponent, depending on the nature of the enemy. Origin of Thang Ta lies in the very origin of the Meetei Race and the history of Manipur.

In the year 1987, the first State Level Thang Ta sport competition was organized for the first time in the history of Thang Ta, at Yumnam Huidrom, Imphal. With the increasing popularity of Thang Ta nationally, Thang Ta Federation of India (TTFI) was established in 1993. Many National Thang -Ta Championships were organized in Manipur, in which many states participated. Thang -Ta was introduced as a demonstration game in the 5th National Games, held at Imphal in the year 1999. The Federation has organized many national Championships, including one national federation cup championship at Delhi on 2011, for selecting team to represent India in the 1st International Championship. The fame of the Thang Ta sport spreading outside India. Starting with Bangladesh in 2003, Thang Ta sport movement has spread to many countries- Burma (Myanmar), Nepal, Bhutan, Shri-Lanka, Afghanistan, Indonesia, Malaysia, Singapore, Philippines, China, Canada, Japan, USA etc, the number increasing day by day. The World Thang-Ta Council (WTTC)/Federation (WTTF) was established in 1993. At present there are more institutions in the valley of the State which impart the knowledge of Manipuri Martial Arts specializing in the traditional use of Thang Ta. (http://epao.net/epSubPageExtractor.asp?src=leisure.Sports.Martial_Arts.Thang_Ta_A_brief_information)

Some of the coaches in Manipur reported that the present day modern combat athletes such as Judo, Taekwondo, Kung fu, and fencing athletes who come from the back ground of Thang- Ta perform better and learn faster than the fresh counterparts. However, data on Nutritional status and physiological profile of Manipuri athletes in general and indigenous athletes in particular is not available.

Manipur has given India some incredible athletes who have done the nation proud with their commendable performances. Sport is hobby for many Manipuris and it comes naturally to them. But it's not enough to earn laurels. Athletes need training – both physical and mental, proper dietary habits, knowledge of sport nutrition. It may be mentioned that five Manipuri players including the country's most pride MC Mary Kom participated in the London Olympics in 2012.

B. NUTRITIONAL STATUS OF ATHLETES

Nutrition plays a very important role in attaining high level of achievements in the field of sports. Nutritional status has a direct bearing on the level of physical performance. Hence, physical fitness and training are very much dependent on nutritional status of sports personnel. Generally most of the athletes have tall, muscular and well balanced physique, which is an indicator of good nutritional status.

Understanding of food and nutritional status of individuals have become two very important issues in the contemporary world. Nutritional and food mistakes affect people's health status. Nutritional status is an expression of the degree to which physiological nutritional needs are met. Normal nutritional status is characterized by a BMI of between 18.5- 24.9 kg/m², an optimal intake of calories, macro and micronutrients, which allows a normal physical and intellectual activity, to ensure growth and a corresponding development of the individual and maintain health that contribute to increased quality of life (Simu, 2001).

Anthropometric measurement, biochemical parameters, clinical assessment, dietary assessment are good indicators of nutritional status of an individual (Srilakshmi, 2010).

Schick *et al.*, (2010) studied the physiological profile of mixed martial arts with other combat sports. Eleven male fighters (age 25.5 ± 5.7 yrs, height 174.8 ± 5.3 cm, body mass 77.4 ± 11.4 kg) were involved in the study. Body composition, vertical jump, flexibility, grip strength, maximum oxygen consumption and relative one repetition – maximum bench press and squat were measured. It was found that Mixed Martial Art fighters had similar body fat percentage to Judoka but greater than wrestlers and Kung fu. Their maximum oxygen uptake was comparable to wrestlers but greater than judokas and less than kick boxers. These fighters were less flexible than Kung fu athletes but as flexible as a wrestler. These fighters had less vertical jump than wrestlers but both of them were greater than Kung fu. They had similar relative bench press and relative squat compared to Judokas. Boxers had greater right grip strength than Mixed Martial Art fighters. This study reported that amateur Mixed Martial Art fighters have a physiological profile similar to judokas and wrestlers.

Almeida *et al.*, (2003) studied to assess the dietary and anthropometric profiles of 25 female adolescent volleyball players of Rio de Janeiro (15-20 years old). Anthropometric assessment was obtained by body mass, stature, skinfold and circumference measurements. The results of anthropometric evaluation showed that athletes had body mass of 64.35 ± 6.12 kg, stature of 1.74 ± 0.06 m and fat mass of 20.51 ± 2.43 . Diets consisted of high energy and protein intake, and low carbohydrate intake. The consumption of calcium, folate and vitamin E was below the recommendations. These athletes were going through a period of intense growth and development associated with rigorous training; therefore, necessary for them to receive individualized nutritional orientation to improve their performance and quality of life.

Rusu (2010) studied nutritional status based on anthropometric measurements, measures of body adiposity. The study has been carried on handball, basketball, Football athletes. It was observed that they are within normal limits of proportionality given in literature. In terms of anthropometry indices analyzed in tests can be observed a high difference between of handball and football groups and a percentage appreciation between the basketball and handball groups, respectively the basketball and football groups. All results showed an accumulation of body fat per cent for the three samples taken in study. It was concluded that the BMI index analysis shows that basketball and football athletes were fit into normal and handball is a lot less high degree of overweight. These reveal that nutritional status should constitute a priority objective of each current clinical examination which is reflecting the degree to which physiological nutritional needs are met.

Alves *et al.*, (2012) studied to determine the physiological, anthropometric, performance, and nutritional characteristics of the Brazil Canoe Polo National Team. Ten male canoe polo athletes (age 26.7 ± 4.1 years) performed a battery of tests including assessments of anthropometric parameters, upper-body anaerobic power (Wingate), muscular strength, aerobic power, and nutritional profile. Body fat, $12.3 \pm 4.0\%$; upper body peak and mean power, 6.8 ± 0.5 and 4.7 ± 0.4 W. kg^{-1} , respectively; 1-RM bench press, 99.1 ± 11.7 kg; peak oxygen uptake, 44.3 ± 5.8 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$; total energy intake, 42.8 ± 8.6 $\text{kcal} \cdot \text{kg}^{-1}$; protein, carbohydrate, and fat intakes, 1.9 ± 0.1 , 5.0 ± 1.5 , and 1.7 ± 0.4 $\text{g} \cdot \text{kg}^{-1}$, respectively; mean heart

rate, 146 ± 11 beats.min⁻¹; plasma lactate, 5.7 ± 3.8 mmol. L⁻¹ at half-time and 4.6 ± 2.2 mmol.L⁻¹ at the end of the match; effort time (relative to total match time), $93.1 \pm 3.0\%$; number of sprints, 9.6 ± 4.4 . The results of this study showed to assist coaches, trainers, and nutritionists in developing more adequate training programmes and dietary interventions for canoe polo athletes.

Sousa *et al.*, (2008) studied the nutrient and water intake among adolescent from sport federation in federal district of Brazil. It was found that the total energy expenditure was higher among endurance athletes ($P < 0.001$) following their higher training time ($P < 0.001$) when compared to adolescents engaged in strength-skill or mixed sports. Total energy intake was only significantly higher among endurance-engaged females ($P < 0.05$). Protein intake of males was above the guidelines established by the ACSM for all sports groups. All male sport groups fulfilled the intake levels of carbohydrate per kg body weight but only females engaged in endurance sports fulfilled carbohydrate guidelines. Intakes of micronutrients was low, few adolescents ($< 5\%$) presented adequate intake for calcium, fiber, drinking water and beverages. For micronutrients, prevalence of adequacies was lower for females than males, except for liquids and water. Nutrition guidance is needed to help adolescents fulfill specific guidelines of macronutrient intake for their sports and to improve their intake of micronutrients and water. Special attention should be given to female adolescent athletes.

Schroder *et al.*, (2004), studied the dietary habit of 55 elite Spanish basket ball players through 24 hour recall method. Energy consumption of the athletes was high in comparison to other elite teams sport athletes. Intake of protein, fat, saturated fatty acids, mineral and most vitamins exceeded the RDA's for these macro nutrients whereas intake of carbohydrate and vitamin E failed to meet the guidelines. Martin *et al.*, (2006), reported that the nutritional intake of 16 female England soccer players. Their energy intake was low (1904 ± 366.3 kcal) in relation to previous recommendation for soccer players Energy expenditure (2153.5 ± 596.2 kcal) was not significantly different ($p > 0.05$) from intake. Carbohydrate ($53.8 \pm 6.8\%$), protein ($16.8 \pm 2.1\%$), and fat ($28.8 \pm 6.6\%$) intake were in line with recommendation. Fluid intake (2466 ± 1350.5 ml-1) was sufficient to meet base line recommendation, but would need to be higher to meet the additional requirement of training and

competition. With the exception of Vitamin A and iron, all micronutrient intakes were higher than the RDA.

Rossi *et al.*, (2009) studied to evaluate food intake by Brazilian high-rank taekwondo athletes in order to assess nutritional adequacy and draw comparisons with other sport modalities of fight. Five male athletes of mean age 23.4 ± 2.5 years; weight 61.8 ± 5.7 kg; stature 171.9 ± 6.2 cm were involved. They had BMI of 20.8 ± 0.7 kg/m² and fat percentage $8.2 \pm 3.2\%$. It was found that the nutritional inadequacies were detected concerning protein and fiber intake. Although the intake of most of the analyzed macro and micronutrients was adequate, an investigation during different training/competition periods may reveal further details on the risk of a sport with weight categories and consequent weight cycles to obtain competitive benefits, a strategy commonly reported for other sports.

Byars *et al.*, (2010) studied the influence of a pre-exercise sports drink on factors related to maximal aerobic performance. Twenty-nine male and female college students varying in levels of aerobic fitness participated in a randomized crossover administration of pre-exercise sports drink (containing 14 g/serving of fructose, medium-chain triglycerides, and amino acids mixed with 8 oz. of water) and placebo 30 minutes prior to performing a treadmill test with approximately one week separation between the trials. VO_2 max, maximal heart rate, time to exhaustion (Time), and percentage estimated non-protein fat substrate utilization during two a priori sub maximal stages of a graded exercise testing were evaluated. It was found that VO_2 max mean value of the pre-exercise sports drink trial was significantly greater than the placebo trial ($P < 0.01$). The mean value for time was also observed to be greater for the pre-exercise sports drink trial compared to placebo ($P < 0.05$). Additionally, percentage of fat substrate during sub maximal stages of the exercise test was greater for pre-exercise sports drink trial in comparison to placebo ($P < 0.01$).

Veena and Subapriya (2010) reported that there exists an inadequacy in the dietary intake of important nutrients among both athletes and non athletes with a higher deficit among athletes. Athletes exhibit negative energy balance which reflects not only on their health status but also upon their athletic performance. More number of athletes were under weight and anemic when compare to non athletes, driving

home the fact that their diet lacks the ability to help them cope with the increased demands of athletic activity making proper nutritional care greatly essential. Kavitha *et al.*, (2001) studied the nutritional intake of 18 male and 12 female trained athletes in the age group of 16 – 20 years of age. It was found that the mean intake of energy, protein, fat and carbohydrate as well as micro nutrients intake were higher in male athletes than the female athletes.

Nudri *et al.*, (2003) studied on the Nutritional Status of Physically Active Men in Kota Bharu. This study concluded that nutritional status in the athlete and exercise groups was unsatisfactory. The incidence of poor health status related to over nutrition in the active groups was rather high and needs attention from health professionals. Further studies are needed to determine nutritional practices among physically active groups.

Sumida *et al.*, (2012) studied the Evaluation of bone, nutrition, and physical function in Shorinji Kempo (Chinese martial art) athletes. All the athletes had a lower daily calcium intake than the adequate intake, 12 (75.0%) had a lower daily vitamin D intake, and 15 (93.8%) had a lower daily vitamin K intake. Significant positive correlations were found between the vertical jump height, and the daily energy, and protein intakes. The results suggested that fractures are a common injury in Shorinji Kempo athletes, and that some Shorinji Kempo athletes need to improve their bone mass, bone metabolism, and nutritional status in order to strengthen bone and improve physical function.

Shriver *et al.*, (2013) studied the dietary intakes and eating habits of female college athletes and compared them with the minimum sports nutrition standards. 52 female college athletes where anthropometric measurements and dietary assessment was done by using a 3-day food record, a 24-hour recall, and a nutrition questionnaire. The statistical tests indicated that the energy and carbohydrate intakes were below the minimum recommended amount ($p < .001$), with only 9 per cent of the participants meeting their energy needs. Seventy-five percent of the participants failed to consume the minimum amount of carbohydrates that is required to support training. The majority of the participants reported no regular breakfast, 36 per cent consumed <5 meals/day, and only 16 per cent monitored their hydration status. The study concluded that effective nutrition interventions are needed to improve dietary intakes and eating habits of female college athletes.

Kutlu and Guler (2006) studied to assess over time the hydration status of taekwondo athletes during a preparatory camp. Body mass was also measured at the same instants. Body mass was essentially the same on each of the measurement days (62.6 ± 12.2 , 62.7 ± 12.3 and 62.2 ± 12.6 kg, respectively). The study found that some of the taekwon-do athletes were slightly hypo hydrated in the morning on each of the test days, but there was no evidence to suggest that most of the athletes further restricted their fluid intake to make weight.

Martinez *et al.*, (2011) evaluated the nutritional and anthropometric profiles of young swimmers belonging to semiprofessional teams. Thirty-six Caucasian adolescent swimmers (22 boys and 14 girls) participated voluntarily in the study. Anthropometric data, dietary intake, and blood parameters were determined. Female swimmers had greater values of triceps, suprailiac, and abdominal skinfolds. Energy intake and protein intake per kilogram of body weight were significantly greater in boys compared to in girls. Energy intake of boys and girls was below their requirements. In contrast, protein intake doubled the requirements of the study population. Furthermore, inadequate intake of carotenes, vitamin A, vitamin E, vitamin D, and folic acid was found in both boys and girls; girls also had inadequate intake of iron and calcium. Plasma levels of iron, vitamins C and E, and carotenes were similar in male and females swimmers, and they were within the normal range. Adolescent swimmers had low average total energy intakes, excessive protein intake, and lower intake of several micronutrients in both sexes.

Ruiz *et al.*, (2005) evaluated the dietary practices of soccer players of different ages. The diets of the members of four soccer teams (mean ages of 14.0, 15.0, 16.6 and 20.9 years, respectively) were examined. It showed that the caloric intake per kilogram of body mass was significantly higher among the youngest players when compared with the adult players. The contribution of carbohydrates to total energy intake was lower than that recommended for athletes. This contribution decreased with age from 47.4 per cent of total energy intake for the 14-year-olds to 44.6 per cent for the adult layers. No significant differences in protein or total fat intake were detected among the teams examined. Overall, the results showed that the nutritional intake of the soccer players was not optimal, and that this intake was poorer among the adult players than among the adolescents. It was recommended that nutritional

education should be given to soccer players at an early age and should continue throughout adolescence, not only with a view to improving performance but also to promoting more healthy dietary practices in the long term.

Artioli *et al.*, (2009) determined the physiological, nutritional, and performance profiles of elite Olympic Wushu (kung-fu) athletes. Ten men and four women elite athletes took part in the study. Body composition, nutritional assessment, upper-body Wingate Test, vertical jump, lumbar isometric strength, and flexibility were measured. Blood lactate was determined at rest and after the Wingate Test. Blood lactate was also determined during a training session (combat and Taolu training). It was found that in both male and female, low body fat, high flexibility, high leg power, high lumbar isometric strength, moderate arm mean and peak power, and elevated blood lactate after the Wingate Test and during training. Men athletes consume a high-fat, low-carbohydrate diet, whereas women consume a moderate, high-carbohydrate diet. Energy consumption was markedly variable.

Gibson *et al.*, (2011) studied the Nutrition status of junior elite Canadian female soccer athletes. It was concluded that a high proportion of players were not in energy balance, failed to meet carbohydrate and micronutrient recommendations, and presented with depleted iron and vitamin D status. Suboptimal nutrition status may affect soccer performance and physiological growth and development. More research is needed to understand the unique nutrition needs of this population and inform sport nutrition practice and research.

Silva *et al.*, (2012) studied the pre-game hydration status and fluid balance of elite young soccer players competing in a match played in the heat (temperature $31.0 \pm 2.08^{\circ}\text{C}$, relative humidity (48.0 ± 5.0) per cent) for an official Brazilian soccer competition. Fluid intake was measured during the match, as were urine specific gravity and body mass before and after the game to estimate hydration status. Data were obtained from 15 male players (age 17.0 ± 0.6 years, height 1.78 ± 0.06 m, mass 65.3 ± 3.8 kg); data are only analysed for 10 players who completed the full game. The mean sweat loss of players amounted to 2.24 ± 0.63 L, and mean fluid intake was 1.12 ± 0.39 L. Pre-game urine specific gravity was 1.021 ± 0.004 , ranging from 1.010 to 1.025. There was no significant correlation between sweat loss and fluid or between urine specific gravity and fluid intake. This study concluded that

effective strategies is highly needed to improve fluid replacement are needed for players competing in the heat.

C. NUTRITIONAL REQUIREMENTS OF ATHLETES

Nutrition for sportspersons plays an important role in achieving optimal performance. Nutritional requirements of athletes should also take care of the general needs including tissue maintenance and require ensuring proper health in latter life. A balance diet containing all the essential nutrients such as carbohydrate, protein, fat, vitamins and minerals in optimal levels as well as water and fibers in required amounts will help in maintaining good health and desirable body size and composition to achieve desirable performance. Athletes needs the same amounts of essential nutrients as non athletes with varied increases in their calorie requirements as well as other macro and micro nutrients due to increase physical activity (Venkataramana, 2010)

The fundamental difference in dietary intake between an athlete and non-athlete is that athletes must consume adequate energy to meet the demands of intense training and competition (Tarnopolsky & Gibala, 2005). From The Joint Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine, *athletes should* consumed adequate food and fluid, before, during, and after exercise to maintain blood glucose during exercise, maximize exercise performance, and improve recovery time. Athletes should be well-hydrated before beginning to exercise; athletes should also drink enough fluid during and after exercise to balance fluid losses.

Fat intake should be adequate to provide the essential fatty acids and fat-soluble vitamins, as well as to help provide adequate energy for weight maintenance. Overall, diets should provide moderate amounts of energy from fat (20 per cent to 25 per cent of energy).

Carbohydrates are important to maintain blood-glucose levels during exercise and to replace muscle glycogen. Recommendations for athletes range from 6 to 10 g/kg body weight per day. The amount required depends upon the athlete's total daily energy expenditure, type of sport performed, sex of the athlete, and environmental conditions.

Protein requirements are slightly increased in highly active people. Protein recommendations for endurance athletes are 1.2 to 1.4 g/kg body weight per day, whereas those for resistance and strength-trained athletes may be as high as 1.6 to 1.7 g/kg body weight per day.

Dehydration decreases exercise performance; thus, adequate fluid before, during, and after exercise is necessary for health and optimal performance. Athletes should drink enough fluid to balance their fluid losses. Two hours before exercise 400 to 600 mL (14 to 22 oz) of fluid should be consumed, and during exercise 150 to 350 mL (6 to 12 oz) of fluid should be consumed every 15 to 20 minutes depending on tolerance. After exercise the athlete should drink adequate fluids to replace sweat losses during exercise. The athlete needs to drink at least 450 to 675 mL (16 to 24 oz) of fluid for every pound (0.5 kg) of body weight lost during exercise.

Phillips *et al.*, (2007) reported that to attain peak levels of performance athletes clearly need to be aware of their dietary intake of protein, as well as carbohydrate and a number of other micronutrients and minerals. Notwithstanding, it appears that emerging dietary guidelines for protein are in the range of 1.2–1.6 g protein per kilogram body weight. This level is greater than the RDA, with the general recommendation that the RDA is a protein intake designed simply to alleviate deficiency. Protein quality also appears to be important in maximizing the accretion of muscle proteins, so athletes would do well to focus on high-quality protein sources such as dairy protein, eggs, and lean meat. When athletes find it inconvenient to consume such protein sources, more portable protein sources, particularly protein supplements, offer a practical alternative. The content of these protein supplements should be closely scrutinized by athletes for quality, however, because protein bars and drinks are highly heterogeneous in terms of their composition. The high-quality protein dose that appears to maximally stimulate muscle protein synthesis is close to 20–25 g; above this point protein synthesis is not additionally stimulated, but increases in amino acid oxidation and urea synthesis may result.

Aerenhouts, (2011) estimated the macronutrient intake; height, weight, and body composition of 60 adolescent sprint athletes every 6 months over 3 years. Seven-day food records were analysed based on the Belgian and Dutch food

databanks. The age of participants at the start of the 3-year study was 14.8±1.6 years for female athletes and 14.7±1.9 years for male athletes. Girls and boys gained height (3.4±4.6 cm and 5.9±6.6 cm respectively) and weight (5.6±3.5 kg and 8.7±5.5 kg respectively), whereas percent body fat remained unchanged in both girls and boys (around 17.0 per cent and 8.5 per cent respectively). Mean protein intake of around 1.5 g · kg⁻¹ body weight was within recommendations on each occasion for both sexes. Carbohydrate intakes between 5 and 7 g · kg⁻¹ body weight support a training programme of moderate intensity. Total and saturated fat intakes were high at the start of the study (girls: 31.8±3.5 per cent and 12.2±2.0 per cent of energy intake; boys: 30.3±4.6 per cent and 12.0±1.9 per cent of energy intake) and it appeared to be difficult to achieve and maintain lower intakes. Consistent low fluid intakes around 40 ml · kg⁻¹ body weight were observed. General non-stringent advice for improvement of the diet resulted in significant favorable changes only for the consumption of wholegrain bread, vegetables, and soft drinks. Dietary habits of adolescent sprint athletes are not always according to guidelines and are relatively stable but repeated advice can induce moderate improvements

Meeting energy needs is the first nutrition priority for athletes. Achieving energy balance is essential for the maintenance of lean tissue mass, immune and reproductive function, and optimum athletic performance. Energy balance is defined as a state when energy intake (the sum of energy from food, fluids, and supplement products) equals energy expenditure (the sum of energy expended as basal metabolism, the thermic effect of food, and any voluntary physical activity) (Swinburn and Ravussin, 1993). Inadequate energy intake relative to energy expenditure compromises performance and the benefits associated with training. With limited energy intake, fat and lean tissue mass will be used by the body for fuel. Loss of muscle results in the loss of strength and endurance. In addition, chronically low energy intake often results in poor nutrient intake, particularly of micronutrients

Motonaga *et al.*, (2006) stated that the total energy expenditure of the endurance athletes was higher than expected and significantly affected by exercise energy expenditure indicating that the total energy expenditure (TEE) of athletes in general must be carefully evaluated before incorporating nutritional support for them. Hunter *et al.*, (2000) reported that in response to resistance training, TEE increased by Respiratory Exchange Ratio (RER) decreased. The increased in TEE accrue as a

result of increased in both Resting Energy Expenditure (REE) and physical activity. This result suggest that resistance training may have value in increasing energy expenditure and lipid oxidation rate in older adult their by improving their metabolic profile.

Venkatramana (2010) reported that all sporting events involve same degree of intense muscular training, which depends on the type of sport and phase of training. Hence the nutritional needs, especially, the energy requirement differ greatly from athlete to athlete. The energy requirement of any athlete is also influence by the body size and composition, age and gender apart from the type of sports, different phase of training, non training activities. Pritzlaff (2000) concluded that a positive relationship exist between exercise intensity and both Carbohydrate expenditure during exercise and fat expenditure during recovery. The increase in fat expenditure recovery with higher exercise intensities is related to growth harmonic. Regular exercise may decrease energy balance through an increase in energy expenditure or an increase in fat oxidation. It may also contribute to weight loss by modulating nutrient intake.

Juzwiak *et al.*, (2008) evaluated the body composition and dietary intake of 44 adolescent tennis players. After being divided into two groups (age 10–13 years and age 14–18), the players had their weight, height, and sexual maturation assessed. Dual-energy X-ray absorptiometry was used to assess body composition. Food intake was obtained from a non-consecutive 4-day food record. Body mass index and body fat for tennis practice were adequate for 89 per cent and 71 per cent of the tennis players respectively, regardless of age group. A calorie deficit greater than 10 per cent of energy expenditure was observed in 32 per cent of the sample. Fifty percent of the athletes consumed carbohydrates in accordance with recommended values. Protein and lipid intakes were above recommended values, while fibre, calcium, potassium, magnesium, and folic acid intakes were below recommendation for 98 per cent, 80 per cent, 100 per cent, 100 per cent and 98 per cent of the tennis players respectively. It was observed that nutritional deficiencies represent an additional barrier for adolescents engaged in competitive sports to achieve an optimum nutrition to maintain growth, health, and performance.

The consumption of beverages during exercise not only helps prevent dehydration (which is associated with an increased stress hormone response) but

also helps to maintain saliva flow rate during exercise. Saliva contains several proteins with antimicrobial properties, including immunoglobulin-A (IgA), lysozyme and α -amylase. Saliva secretion usually falls during exercise. Regular fluid intake during exercise is reported to prevent this effect and a recent study (Bishop *et al.*, 2000) has confirmed that regular consumption of lemon-flavored carbohydrate-containing drinks helps to maintain saliva flow rate and hence saliva IgA secretion rate during prolonged exercise compared with a restricted fluid intake regimen.

Sawka *et al.* (2007) reported that the athletes should develop personalized drinking plan to match rates of sweat loss as well as practical so that the total fluid deficit incurred during the event is kept below about 2% of body mass. Water is an important nutrient for the athletes. Athletes should start any event and will replace as much loss fluid as possible by drinking chilled liquid at frequent interval during the event (www.timetorun.com, 2006). Jackson *et al.*, (1995) reported that using a sports drink during high intensity stop and go sport like volley ball, sprint cycling helps delay fatigue and maintain hydration.

Many previous studies have demonstrated that, even if fluid intake is adequate, when the electrolyte concentrations are low there is an increase in urinary excretion and, consequently, the subjects are in negative fluid balance (Aragón-Vargas and Madriz-Dávila 2000; Maughan and Leiper 1993; Shirreffs and Maughan 1993). In addition, previous research indicates the importance of the inclusion of sodium in rehydration beverages (Maughan and Leiper 1994; Shirreffs and Maughan, 1998). Therefore, both the volume and electrolyte composition of fluid ingested should be considered in the post exercise rehydration recovery process.

Singh (2010) reported that maintaining fluid balance is an important factor in preserving various functions and supporting exercise performance in hot environment. Fluid is lost mainly through sweating. Prolonged bout of exercise in hot environment can had to excess of 1 litre of body fluid per hour to be lost. Dehydration and hyperthermia can adversely affect mental and physical performance, unless the athletes consume fluids to replace the losses. It is therefore pertinent to drink enough fluid before the game and at rest breaks to avoid dehydration and fatigue. Dilute carbohydrate – electrolyte drinks are best for fluid replacement which also supply some substrate for the increasing muscle. Athletes, especially in the tropics are

advised to drink to replace their sweat losses than simply to satisfy their thirst. The rehydration fluid must contain sufficient sodium to maintain the thirst stimulates and to promote the retention of the ingested fluid.

Noakes (2002) reported that confusion still remain about the real danger of dehydration. He contends that there is no evidence showing that dehydration level during competition (2-8%) impaired health or performance. There is an urgent need for properly controlled trials on the effect of weight loss (dehydration) during exercise on performance during weight – bearing activities like long distance. Oppliger (2002) found that dehydration not only reduces athletic performance but also place athlete at risk of health problem and even death.

Volpe *et al.*, (2009) studied the pre-practice hydration status of collegiate athletes and determine the factors that might influence that status. 138 male and 125 female athletes age (19.9 ±1.3 years), height (165.8± 42.9 cm), mass (77.4 ±17.5 kg) from an NCAA Division I New England university were participated in the study. One spontaneously voided (spot) urine sample was collected from each participant before his or her team practice and was measured 2 times. A refractometer was used to analyze the amount of light that passed through a small drop of urine and assess urine specific gravity. Fluid intake and menstrual history for women were also collected. The result found that thirteen percent of student-athletes appeared significantly hypohydrated, with a mean urine specific gravity of 1.031± 0.002; 53 per cent appeared hypohydrated, with a mean urine specific gravity of 1.024 ± 0.003; and 34 per cent appeared euhydrated, with a mean urine specific gravity of 1.012 ± 0.005. A greater percentage of men (47per cent) than women (28 per cent) were hypohydrated. In women, no difference was evident between the luteal and follicular phases of their menstrual cycles). The study concluded that before activity, athletes were hypohydrated at different levels. A greater percentage of men than women were hypohydrated. Menstrual cycle phase did not appear to affect hydration in women.

Almond *et al.*, (2003) found that 13 percent of athletes experienced hyponatremia risk factor includes female gender slower finishing terms and excess fluid consumption. Montain (2006) suggested that athletes to prevent hypomatremia should focus on minimizing overdrinking relatives to sweating rate after sweating salt

depletion in these excreted salty sweat. This stimulation demonstrates the complexity of defining fluid and electrolyte consumption rate during athletic competition.

Plasma electrolyte concentration remains unchanged or become elevated during dehydration state, while intracellular concentration of some electrolytes increase in proportion to the severity of dehydration (Costill *et al.*, 2004). However, human perspiration may be considered as a filtrate of plasma (Costill, 2004). The precise composition of which may vary according to whether produced by exercise or thermal factors. The physiological significance of electrolyte losses in perspiration during exercise may be considered of secondary importance to body water loss (Costill, 2004).

Sodium and potassium are the two electrolytes most often added to sport drinks. Replacement of these electrolytes is needed during short burst of exercise. Since sweat is approximately 99 percent water and less than one percent electrolyte. Water is combined with a well balanced diet and electrolyte levels in the body. However, replacing electrolyte may be beneficial during continuous activity of longer activity of longer than two hours especially in a hot environment (Chandra Sekhar and Jain, 2003).

D. ROLE OF SPORTS DRINKS IN ATHLETICS PERFORMANCE

Fluid intake during prolonged exercise is effective in improving exercise performance and delaying the onset of fatigue Below *et al.*, (1995). Sports drinks are designed to deliver a balanced amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel during exercise. According to various expert position stands, to provide rapid delivery of fluid and fuel and to maximize gastric tolerance and palatability, sports drinks should be within a compositional range of 4-8% (4-8 g/100 ml) carbohydrate and 23-69 mg/100mL (10-30 mmol/L) sodium (Rodriguez *et al.*, 2009a).

The aim of the athlete who ingests drinks before, during or after training or competition is to improve performance, and this can be achieved by minimizing the impact of the factors that cause fatigue and impair the performance of skilled tasks. The two factors that have been considered contribute most to the onset of fatigue in exercise are the depletion of the body's carbohydrate reserves and the onset of

dehydration resulting from the loss of water and electrolytes in sweat (Maughan, 1994).

Despite the definitive statement by the American College of Sports Medicine (1984) in *Position stand on the prevention of thermal injuries in distance running*, that cool water is the optimum fluid for ingestion during endurance exercise, there is a substantial body of evidence to support the suggestion that there are good reasons for taking drinks containing added sugars and electrolytes. Commonly-formulated sports drinks are intended to serve a variety of purposes. These include: supply of substrate, prevention of dehydration, electrolyte replacement, pre-exercise hydration, post-exercise rehydration. Sports drinks should be designed to deliver a balanced amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel during exercise. According to various expert position stands, the compositional range which provides rapid delivery of fluid and fuel and maximises gastric tolerance and palatability is 4–8% (4–8 g/100 ml) carbohydrate and 23–69 mg/100 mL (10–30 mmol/L) (Rodriguez et al., 2009b).

Khanna and Manna (2005) investigated the effect of oral carbohydrate-electrolyte supplementation on sports performance and cardiovascular status of the national level male athletes during exercise and recovery. Ten male athletes (age range: 20-25 yr) were involved in the study. The experiment was performed in laboratory (25 degrees C and 60% relative humidity) in two phases; phase 1 - no supplementation, and phase 2 - a 5 g per cent carbohydrate-electrolyte drink was given orally during exercise and a 12.5 g per cent carbohydrate-electrolyte drink during recovery. Subjects performed an exercise test at 70 per cent of VO_2 max. Performance time, heart rate during exercise and recovery were noted, blood samples were collected during exercise and recovery for the analysis of glucose and lactate levels in both the phases. Significant improvements were noted in total endurance time, heart rate responses and blood lactate during exercise at 70 per cent VO_2 max after the supplementation of 5 g per cent carbohydrate-electrolyte drink. However, no significant changes were noted in blood glucose and peak lactate level irrespective of supplementation of carbohydrate-electrolyte drink. Significant improvement in cardiovascular responses, blood glucose and lactate removal were noted during recovery following a 12.5 g per cent carbohydrate-electrolyte

drink. Carbohydrate-electrolyte drink can increase endurance performance as well as enhance lactate removal and thereby delaying the onset of fatigue.

Snell *et al.*, (2010) studied the Comparative effects of selected non-caffeinated rehydration sports drinks on short-term performance following moderate dehydration on eight healthy males. The study involved a within subject, blinded, crossover, placebo design. Initially, all subjects performed a baseline exercise test using an individualized treadmill protocol structured to induce exhaustion in 7 to 10 min. On each of the three subsequent testing days, the subjects exercised at 70-75 per cent VO_2 max for 60 min at 29-33°C, resulting in a dehydration weight loss of 1.8-2.1 per cent body weight. After 60 min of rest and recovery at 22 C, subjects performed the same treadmill test to voluntary exhaustion, which resulted in a small reduction in VO_2 max and a decline in treadmill performance by 3 per cent relative to the baseline results. Following another 60 min rest and recovery, subjects ingested the same amount of fluid lost in the form of one of three lemon-flavored, randomly assigned commercial drinks, namely Crystal Light (placebo control), Gatorade® and Rehydrate Electrolyte Replacement Drink, and then repeated the treadmill test to voluntary exhaustion. The result showed that simple transportable monosaccharide and sodium are important for maximal exercise performance and effective recovery associated with endurance exercise induced dehydration.

Byars *et al.*, (2010) examined the effects of a modified Pre-exercise sports drinks formulation (known as EM-PACT™) from earlier investigations on factors related to maximal aerobic performance during a graded exercise test. Twenty-nine male and female college students varying in levels of aerobic fitness participated in a randomized crossover administration of Pre-exercise sports (containing 14 g/serving of fructose, medium-chain triglycerides, and amino acids mixed with 8 oz. of water) and placebo 30 minutes prior to performing a treadmill test with approximately one week separation between the trials. VO_2 max, maximal heart rate, time to exhaustion, and percentage estimated non-protein fat substrate utilization, during two a priori sub maximal stages of a graded exercise testing were evaluated. The result reveal that the modified Pre-exercise sports formulation utilized in this investigation supports the findings of the previous investigation and its efficacy for enhancing indices of aerobic

performance (specifically VO₂ max, Time, & non protein fat substrate) during graded exercise testing.

Kalpana *et al.*, (2013) studied the effect of sugarcane juice on exercise metabolism and sport performance of athletes in comparison to commercially available sports drinks. Fifteen male athletes (18-25 yrs) were participated in the study. They performed cycle until volitional exhaustion at 70 per cent VO₂ max on three different trials viz. plain water, sports drink and sugarcane juice. In each trial 3ml/kg/BW of 6 % of carbohydrate fluid was given at every 20 min interval of exercise and a blood sample was taken to measure the hematological parameters. During recovery 200 ml of 9% CHO fluid was given and blood sample was drawn at 5, 10, 15 min of recovery. The result indicated that ingestion of sugarcane juice showed significant increase ($P<0.05$) in blood glucose levels during and after exercise compared to Sports drink and Plain water. However, no significant difference was found between plain water, sports drinks and sugarcane juice for total exercise time, heart rate, and blood lactate and plasma volume. It was concluded that sugarcane juice may be equally effective as sports drink and plain water during exercise in a comfortable environment (<30°C) and a more effective rehydration drink than sports drink and plain water in post exercise as it enhances muscle glycogen resynthesis.

E. HEALTH BENEFITS OF *HIBISCUS SABDARIFFA LINN*

Mahadevan *et al.*, (2009) reviewed that *Hibiscus sabdariffa Linn* is a shrub in the family of Malvaceae. It is thought of native to Asia (India to Indonesia) or tropical Africa. This crop is cultivated in the month of April to November the edible calyces are cultivated after 15-20 days of flowering. The micro nutrient composition of *Hibiscus sabdariffa* calyx, seed and leave parts varies between studies, probably due to different varieties, genetic, environmental, ecology and harvest conditions of the plant. The nutrient composition of *Hibiscus sabdariffa* calyx and seed was different depending on Ecotype (Atta *et al.*, 2013). Ahmed and Abozed, (2015) studied the crackers incorporated with roselle calyx residue after juice extraction and compared with control crackers. The results suggested that Roselle calyx residue is a potential functional food ingredient high in fiber content and antioxidants activity that may be processed into flour and used in food applications, such as baked goods

Hibiscus sabdariffa Linn have a good nutritional Potential (Morton *et al.*, (2000). The hypocholesterolemic, antihypertensive, antioxidant, cardio protective, hepatoprotective effects have been investigated in mice, rabbits and rats (Chen *et al.*, (2004); Carvajal-Zarrabal *et al.*, (2005); Hirunpanich *et al.*, (2006); Ologundudu *et al.*,(2009). However, little studies have been done in humans. The thick, red and fleshy, cup-shaped calyces of the flower are consumed worldwide as cold beverage and as hot drink (sour tea). These extracts are also used in folk medicine against many complaints that include high blood pressure, liver diseases and fever (Dalziel, 1973; Wang *et al.*, 2000; Ross, 2003). The red anthocyanin pigments in the calyces are used as food colouring agents (Esselen and Sammy, 1975).

Ajala Lo *et al.*, 2013 studied the juice extract from *Hibiscus sabdariffa* calyx was analyzed using standard methods to ascertaining its nutritional qualities. The juice extract was found to contain both micro and macro-elements that are beneficial to human nutrition. The value ranged from 280mg/100g (calcium) to 2.44mg/100g (copper). The ascorbic acid and sugar contents of the juice were found to be 31.34 ± 0.48 mg/100g and 11.29 ± 0.08 mg/100g respectively, while the pH was determined to be 3.80 ± 0.01 . The phytochemical screening revealed the present of alkaloids, tannins, flavonoids, cardiac glycosides, anthraquinones and saponins. From the result *Hibiscus sabdariffa* juice contain nutritive elements and the plant metabolites in moderate quantities in the juice extract justify the nutritional potential of the plant calyx

Foline *et al.*, (2011) studied the nutritional quality of three varieties of zobo (*Hibiscus sandariffa linn*) subjected to the same preparation condition. It was found that dark red hibiscus sabdariffa Linn drink has the highest percentage of vitamin C ($7.5g^{-1}$), calcium (4ppm), magnesium (235ppm), and iron (1.17ppm).The vitamin C content was retained after 10 minutes of boiling. Lee *et al.*, (2012) has provided the poly phenol extract of *Hibiscus sabdariffa* helps to protect the liver from the assault or damage associated with acetaminophen, diminishing the mitochondrial dysfunction in vivo and in vitro and oxidative stress. In their study using *Hibiscus sabdariffa* extract as pretreatment increased the glutathione level, decrease the lipid peroxidation level and increased the catalase activity in the liver.

Nnam and Onyeke (2003) studied the chemical composition of Red and yellow varieties of sorrel (*Hibiscus sabdariffa L*) calyces and the drinks made from them were examined for nutrient and antinutrient compositions. Both varieties of the calyces contained appreciable quantities of carbohydrate, iron, ascorbate and β carotene. The yellow variety had higher protein (9.08%) and ascorbate (56.83 mg/100 g) than the red variety. The calyces had traces of tannin and phytate. The drink made with the red calyces contained more total solids and total sugar but lower protein and ascorbate than the drink made with the yellow variety. The two varieties of sorrel calyces are promising sources of iron (800.67–833.00 mg/100 g) and β carotene (281.28–285.29 RE/100 g).

Kilima *et al.*, (2014) studied the Roselle calyx (*Hibiscus sabdariffa Linn*) extracts blended at various proportions of fruit (mango, papaya and guava) juices. Blending of tropical fruit juices with roselle extract have improved mineral composition and antioxidant properties of fruit juices as roselle is a good source of calcium, magnesium and iron.

Previous studies on supplementation of hibiscus sabdariffa Linn was given the following table

Previous studies on supplementation of hibiscus sabdariffa Linn

Title /Author	Sample size and target group	Periods	Parameter measured	Data analysis	Study design	Result
Clinical, Hematological and Biochemical Health Benefit Effects of <i>Hibiscus sabdariffa</i> Lin Dried Calyces Beverage in Human Tazoho etal 2016	N=32 (Normal individual)	Two weeks supplementation during which each subject consumed 1 litre a day (500 mL in the morning and 500 mL in the afternoon).	clinical (systolic and diastolic blood pressure), hematological (RBC, Hb, PCV, MCV, MCH, MCHC, WBC, Lymphocytes, MID cells, Granulocytes, platelet and MPV) and biochemical (TC, HDL-C, LDL-C, TG, serum iron, blood glucose, creatinine, urea, ASAT and ALAT)	One way ANOVA and Newman-Keuls.	Experimental design	A significant increase of RBC, Hb, PCV, MPV, HDL-C, TG and creatinine and a significant decrease of WBC, MID cells, LDL-C were observed during the study period. This shows that H. Sabdariffa L. dried calyces drink can be safely used for people suffering for anemia. It also revealed good cholesterol lowering potential.
The Effect of Green Tea and Sour Tea (<i>Hibiscus sabdariffa</i> L.) Supplementation on Oxidative Stress and Muscle Damage in Athletes. Hadi et al., 2017	N= 54 male soccer player Participants were randomly assigned to three groups First group(n = 18) (Second group n=18) Third group (n=18)	6 week intervention 450 mg/d green tea extract (GTE) in the first), 450 mg/d sour tea extract (STE) in the second and 450 mg/d maltodextrin in the control group	Aspartate aminotransferase (AST), creatine kinase (CK), lactate dehydrogenase (LDH), and oxidative stress biomarkers, malondialdehyde (MDA), and total antioxidant capacity (TAC	Pre and post test		Athletes who received GTE and STE supplements compared with the placebo had a significantly decreased MDA level ($P = 0.008$). Furthermore, STE supplementation resulted in a significant increase in TAC level compared with GTE and placebo groups ($P = 0.01$). Supplementation with GTE and STE had no significant effects on muscle damage indices. This shows that GTE and STE supplementation have beneficial effects on oxidative stress status in male athletes but not on muscle damage status.
Infusion of <i>Hibiscus sabdariffa</i> L. Modulates Oxidative Stress in Patients with Marfan Syndrome Soto et al., (2016)	N= 17 MFS patients (Marfan syndrom	20 g <i>Hibiscus sabdariffa</i> Linn calyces in 1liter water Patient consumed 1 liter/day for 3 months.	Extra cellular super oxide dismutase (ECSOD), glutathione peroxidase (GPx), glutathione-S-transferase (GST), glutathione reductase (GSSG-R), glutathione (GSH), lipid peroxidation (LPO) index, total antioxidant capacity (TAC), and ascorbic acid		prospective and observational study that was carried out in one cohort	Significant decrease in ECSOD , EGPx , GST, GSH , and TAC and ascorbic acid but GSSG-R activity and LPO were increased in MFS patients in comparison to patients receiving the HSL treatment and Control subjects. This shows that infusion of HSL calyces has antioxidant properties that allow an increase in antioxidant capacity of both the enzymatic and nonenzymatic systems, in the plasma of the Marfan syndrome (MSF) patients.
<i>Hibiscus sabdariffa</i> extract reduces serum cholesterol in men and women Lin et al., (2007)	N= 42 (hypercholesterolemic patient)	3 groups: group I (1 capsule of Hibiscus sabdariffa extract during each meal), group II (2 capsules), and group III (3 capsules) and supplemented for one month	Serum cholesterol levels were determined at baseline before the study commenced and at 2 and 4 weeks of the treatment period		Experimental design	The observation of lowered serum cholesterol in these subjects suggests that Hibiscus sabdariffa Extract may be effective in hypercholesterolemic patients.

Summary of supplementation of *Hibiscus sabdariffa* Linn from the previous findings and relevant to the present study:

The phytochemical screening done by Ajala Lo *et al.*, (2013) revealed *Hibiscus sabdariffa* juice contain plant metabolites in moderate quantities. Alkaloids, tannins, flavonoids, cardiac glycosides, anthraquinones and saponins present in the juice extract justify the nutritional potential of the plant calyx. Previous studies on supplementation provide a clear picture of nutritional properties and phytochemical nature of *Hibiscus sabdariffa* Linn on health benefit. Positive findings in the prevention of anaemia (Tazoho *et al.*, 2016), and its antioxidant properties that allow an increase in antioxidant capacity of both the enzymatic and nonenzymatic systems, in the plasma of the Marfan syndrome (MSF) patients (Soto *et al.*, 2016)). It has potential of lowering serum cholesterol (Lin *et al.*, 2007) and beneficial effects on oxidative stress status in male athletes (Hadi *et al.*, 2017). Formulating a low cost nutritional sports drink is a priority to get maximum performance for the athletes in particular for rural athletes who cannot afford to buy expensive commercial sport drink. Further analyzing the previous research, very less study was done on supplementation of *Hibiscus sabdariffa* Linn juice on athletes. The investigator decided to formulate a sports drink using *Hibiscus sabdariffa* Linn dried calyces and assess its effect on performance and biochemical parameters on traditional athletes.

F. IMPORTANCE OF NUTRITION EDUCATION FOR ATHLETES

Basic nutrition education is the first step in helping athletes, coaches and trainers understand the importance of nutrition in athletic performance (Jacobson *et al.*, (2002). Thus there is a need for continuing nutrition education programme for both coaches and sports men and women (Kunkell *et al.*, (2001). Zawila *et al.*, (2003) reported that nutritional knowledge should be a part of the everyday athletic routine. So that, to know what and when to eat and benefit from eating the proper foods.

Sherman and Thompson, (2004) reported that lack of nutrition knowledge can lead to improper dietary practices, which can lead to adverse effects on health and performance of athletes. Female athletes, especially those involved in sports that emphasize body size, are at even greater risk due to weight management issues, in addition to physical performance. Nutrition education is an important tool to

enhances knowledge and improve dietary intake among athletes. Heaney *et al.*, (2011) reported that nutrition knowledge of athletes and its impact on their dietary intake is equivocal. There is a need for high-quality contemporary research on nutrition knowledge using validated tools and its impact on dietary intake. Nutrition education not only needs to provide information and guidance to coaches and athletes about appropriate nutrition behaviors, but also promote positive attitudes and behaviors, recognizing the role nutrition has on performance. This approach would make it more likely that athletes apply their knowledge and understanding of nutrition into practice.

Kelkar *et al.*, (2006) studied nutrition knowledge, attitude and practices of competitive Indian sportsmen. 78 sports men from different sports group were participated and the method of selection was purposive sampling techniques. The age group of the sportsperson were 18-25 years. The sportsmen belonged runners (n=21), boxers (n=21), weightlifters (n=21) and wrestlers (n=15). Elite athletes were generally knowledgeable. The attitudes reflected poor information on Sport nutrition and their practice to copy peers and coaches. They had minimum effort to gather information about nutrition. Weight category sports (boxing, weightlifting and wrestling) were vague concepts about weight loss. They reported supplements were essential to meet increased demands. This study reveals that there is a dearth of nutrition education intervention among Indian sportsmen.

Nichols *et al.*, (2005) reported that 33 per cent collegiate athletes reported not using sports drinks, and only 59 per cent reported drinking 7-10 ounces of fluid 10-20 minutes before competition. Majority (86 per cent) did not weigh themselves before and after practice in order to determine how much fluid to replenish. Overall collegiate athletes had adequate knowledge on fluid replacement, but did not know the specific amounts of fluids that should be consumed and did not practice the knowledge they reported.

Juzwiak (2004) studied the dietary practices recommended by coaches working with adolescent athletes and to assess their nutritional knowledge. Results showed that all coaches recommended general dietary practices during training, with no specific strategies for pre, during, and post-training periods. The main objectives of the recommendations for the training period were weight control and muscle mass gain. Deleterious weight control practices were recommended by 27 per cent of the

coaches. Specific dietary practices pre and post competition were recommended by 93 per cent and 46 per cent of the coaches, respectively. Participants responded correctly to 70 per cent of the nutrition knowledge questions, with no significant differences between sports. The knowledge test identified a tendency to overvalue proteins, excessively low-fat diets, and food myths. These findings indicate the importance of developing strategies that will enhance the nutritional training of coaches.

It is the position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine that physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition. These organizations recommend appropriate selection of foods and fluids, timing of intake, and supplement choices for optimal health and exercise performance. (Rodriguez *et al.*,2009).

Improper nutrition intake in adolescence can jeopardize growth and hinder puberty and it lead to an increase in fractures and anemia as well as a lack of energy to perform in athletic competitions (Cotugna, 2005; Litt, 2004; Zawila, 2003). Therefore, it is essential for young athletes to receive appropriate nutrition education.

Previous studies on Nutrition Education on Athletes was given in the table below
Studies on Nutrition Education

Title /Author	Sample size	Periods	Instruments	Data analysis	Study design	Result
Effect of a nutritional intervention in athletes's body composition, eating behavior and nutritional knowledge :A comparision between Adults and Adolescents. (Nascimento <i>et al.</i> , 2016)	N=32 (21 adult and 21 adolescents) *purposive sampling	45-60 days	24 hour food recall A nutritional knowledge test based on the studies of Gonealves(2009) and Zawila ,steiv &Hoogenboon (2003)	t-test &chi –square test (demographic) paired t-test within group chnges) ANCOVA ANOVA	Quasi- Experimental Clinical trial with pre and post design	Both groups improved their body composition (lean body mass, mid muscle arm circumference), dietary intake and nutrition knowledge.
Nutrition education Abood etal .,(2004)	N=30(15 women soccer team and 12 women swim team athletes)	8 weeks	Nutrition questionnaire (develop by the author) *purposive sampling	Mann whitney U test and Fisher exact probability test	A pretest -posttest control group design	Athletes in the experimental group significantly improved nutrition knowledge and self-efficacy and overall dietary changes.
Nutrition Knowledge, Attitude and Practice of College Sportsmen Nazni and Vimala (2010)	N=102 College athletes(volleyball,32;weightlifter, 25; runner,45) *Purposive sampling		Standardized questionnaire KAP(Knowledge Attitude and Practice) (Mitchell,2004)	Pearson correlation and Z-score	Cohort study	The overall scores indicate that most sportsmen had good knowledge of nutrition and supplements.
Nutrition Knowledge and Attitudes among Clemson University Student-Athletes Dunnigan (2010)	N=95(Clemson University Student-athletes)		New questionnaire was designed adapting the previous survey by Zawilia <i>et al.</i> , (2003)	Multiple regression analysis	Cohort study	Small number of athletes having nutrition courses. Therefore further define the role of nutrition education to the athletes is needed.
Impact of nutrition education programme on college going girls engaged in sports activity. Chaudhary K and Sukhwal I (2016).	N=50 (female athletes) *Purposive sampling	Four hours in a week.	Standard questionnaire	Pre and post test	Experimental design	Nutrition education improved mean awareness score among the athletes.
Effect of Interventions on Performance and KAP of Rural Female Athletes Subapriya M.S, Shajamol P (2010).	N=30(Rural female athletes)		Well framed Questionnaire develop by the author	Pre and post test	Experimental design	Nutrition education had an overwhelming effect on KAP(Knowledge Attitude and Practice)
Assessment of Nutritional Status, Nutritional Knowledge and Impact of Nutrition Education among Selected Sports Persons of Coimbatore District Sangeetha <i>et al.</i> , (2008)	N=20 *Purposive random sampling	One hour contact class	Well frame questionnaire	Pre and post test	Experimental design	Improved nutrition knowledge of the selected sports person
Knowledge, Attitudes and Practices on Hydration and Fluid Replacement among Endurance Sports Athletes in National University of Malaysia (UKM) Sedek <i>et al.</i> , (2015),	N= 80 athletes		Questionnaires adapted from Nicholas et al. (2005)	Frequency analysis		The results of this study identify specific areas of education for athletes with regard to hydration

Summary of Nutrition education from the previous findings and relevant to the present study:

Nutrition education is a key to influence the athletic performance. Various studies have done nutrition education on athletes and their findings suggested that nutrition education increases nutrition knowledge. Athletes in general should have special diet depending on training and particular event as well as proper hydration. Education improved body composition (lean body mass, mid muscle arm circumference), dietary intake and nutrition knowledge on adult and adolescent athletes (Nascimento *et al.*, 2016). Education has improve dietary changes (Abood *et al.*, (2004). Nutrition education had an overwhelming effect on KAP (Knowledge Attitude and Practice), Shaijamoland Subapriya (2010). Therefore the investigator conducted nutrition education program regarding balance diet, sports nutrition KAP on (Knowledge, Attitude and Practice), education about hydration using well framed questionnaire to as a part of intervention study.